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Access to Excellence in Engineering

Visit to Rehabilitation Institute

A Unique Visit to the Rehabilitation Institute of Chicago Highlights the Intersection of Rehab and Computer Science

Interaction with the scientific and medical community serves a vital purpose for engineering students. They need to see leading-edge technology put to work in the most functional settings and challenged to the extreme in order to more fully understand the complex intersection of computer and rehabilitation science. A unique relationship with the Rehabilitation Institute of Chicago (RIC), where Professor Robert V. Kenyon conducts research, allows his class in Human Computer Interaction to learn first-hand how computer scientists contribute to the advancement of rehabilitation science.

Visits to research labs are shaping careers, according to Kenyon, who is affiliated with RIC's Sensory Motor Performance Program and well as the College of Engineering's Electronic Visualization Lab.

"Our students are studying "Universal Design" and specifically the development of computer interfaces that can be used by a wide variety of users - young, old, disabled, and elderly, says Kenyon. "They are learning about this important aspect of software design by reading the burgeoning literature on universal design, presenting papers, traveling to research laboratories, and conducting a semester-long project on human interface design that encompasses the principles of universal design. At the completion of this course, my students have a broad understanding of universal design and an in-depth knowledge of a specific aspect relevant to their own computer science interests."

At RIC, students observe a wide range of research focused on rehabilitating persons who have survived a stroke, limb loss, or traumatic neurological or brain injury.

Student Nakul Drupad Shah called this access to the labs "amazing." In the latest visit, students had the opportunity to examine new methods to promote rehabilitation through devices ranging from robots for retraining patients to walk to prosthetics for limb loss and devices, including virtual reality, to aid stroke victims relearn skills quickly. They were able to voice questions and offer observations – even ideas for future research.

"I had never experienced anything like this. Every single piece of equipment is one of a kind, state-of-the-art technology. These knowledgeable professionals all treated us – budding engineers – with respect for our ideas and curiosity." Shah said.

While the disabilities suffered by the patients can be generalized, they are also each one of a kind. Devices developed by specialized research labs still need to be able to be individualized according to changes in treatment protocol and to match the abilities of each patient. So, students saw many examples of how computer programming leads to the successful rehabilitation of life-changing injury.

Wear a Robot – Relearn to Walk: In the Neuromechanics of Impaired Locomotion Laboratory, where Dr. Keith E. Gordon conducts his research, students encountered "Lokomat" - a robot that stroke and brain injured patients can wear to help them regain the ability to walk through retraining. Research is enhancing understanding of the body's underlying nervous and mechanical systems responsible for walking abnormalities in those with a brain injury. Computer controls and a combination of sophisticated robotics are tuned to the individual's physical stamina and level of progress. Over time, incremental adjustments, now controlled by computer, gradually increase the patient's reliance on his or her own strengthening limbs and less on Lokomat.

While the motivation to regain independence following injury is high, the task can be painful, and since rehabilitation is repetitive, it can be tedious. Students could see that computer science expertise might alleviate tedium problems while motivating other benefits. Adding a visual component to the retraining that would endow the training facility with conditions that patients might encounter in real life could reduce boredom. But also, ideas like this could increase the flexibility of the system and help researchers

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understand how patients might behave under real world conditions.

Targeted Reinnervation – Using Nerves to Move Artificial Limbs: The Neural Engineering Center for Artificial Limbs (NECAL) is home to a new form of prosthetic limb used to aid persons who have suffered amputation. Researchers are working to improve both limb function and quality of life. Currently, amputees are only able to operate one motion at a time with myoelectric prostheses. At the NECAL laboratory researchers are experimenting with

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targeted reinnervation to improve myoelectric prosthesis function by transferring amputated nerves to spare muscle and skin in an amputee's residual limb. Dr. Joseph Barton explained the procedures needed to control these new systems for prosthetic limbs using muscle activity from the remaining limb. The exciting part of this research is that patients operate the prosthetic arm as if it were their own because of the targeted reinnervation, pioneered by lab director Dr. Todd Kuiken.

Unclenching Fists – Grasping Virtual Reality: Stroke induced weakness (hemiparesis) or paralysis (hemiplegia) on one side of the body can leave a patient unable to use muscles in a hand affected by stroke. In the Neuromuscular Hand Rehabilitation Lab, Dr. Derek Kamper is designing rehabilitation devices and procedures that help survivors to regain use of hands.

The current device assists with finger extension. The therapeutic training uses a virtual reality environment to facilitate hand rehabilitation training. They use a 3D model of the index finger to facilitate the study of motor control and to predict the effects of potential therapeutic interventions, while a pneumatic glove trains patients to use their encumbered hand.

The union of VR with therapeutic devices has shown to be promising avenue of recovery, and College of Engineering computer science students are quite familiar with virtual reality. Here, they met patients using a Head Mounted Display showing various objects that they can grasp with their instrumented hand. This appliance aids the patient in opening his or her hand to grasp the virtual object.

Seeing VR applications in use by patients helps the students to comprehend the extent to which patients can grasp a virtual object and their physical limitations. They saw a need in both the design of the visual images and for more interesting tasks to perform.

VRROOM: In the Virtual Reality Robotic Optical Operations Machine Laboratory where College of Engineering alumnus Chris Scharver (2005 MS Computer Science) is a researcher, students were exposed to the design, development, and tests for a new robotic interface for upper-limb rehabilitation of brain-injured individuals. These novel systems safely operate in three dimensions with a large workspace and an appropriately designed visual interface. Again, VR coupled with robots is helping patients recover faster and increasing understanding of what the brain needs to aid healing. Using robotics, Dr. James Patton, the director, demonstrated how the application of forces to the moving hand of a stroke victim could successfully reduce recovery time from days to hours. Other robots produced similar results.

Said Professor Kenyon, who frequently collaborates with Drs. Kamper and Patton on journal articles, "The visit to RIC was an exceptional experience that all of my students said they would remember. With first-hand exposure to physical rehabilitation and the role of the computer, they now have more insight into what is needed to design software for a variety of users, whether disabled or able-bodied."

Darshan Bhatt, a Master's student, remarked that this trip "changed my life." The outcome? Bhatt is now interested in pursuing research in that avenue where computer science and medical rehabilitation meet.

Kenyon encourages alumni to provide access to research for all students, whether through in-depth tours for classes or internships for talented individuals.

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